

AMENDMENTS TO THE DRAWINGS

Please replace the formal drawing sheets currently on file with the replacement drawings sheets submitted herewith. The changes to the drawings are to label Figs. 1-4 as Prior Art and to add new Fig. 8 to show a feature required by the Examiner. No new matter is being added.

REMARKS

Claims 36 through 85 are pending in this case. Claims 36, 49, 62, 63, 71, 73 and 74 have been amended. The specification has been amended to refer to a new figure, Fig. 8A, added as required by the Examiner, and to add the lineage of this application. A substitute set of formal drawings are submitted herewith that reflect the changes required in the Office Action.

The drawings were objected to and the requirement was made to label Figures 1-4 as prior art. As shown above, new Figures 1-4 are submitted herewith to include the designation "Prior Art." The drawings were also objected to for not showing the first metal layer comprising NiN or PdN. In response, a new figure, Figure 8A, is added, together with appropriate additional text in the specification, to show this feature. No new matter has been added.

The specification has also been amended to show the complete lineage of this application, which is a U.S. national stage application based on an international application.

Applicants note appreciation the indication that Claims 63 and 71-73 would be allowable if rewritten so as not to depend from a rejected claim, and with no change in scope. Since appropriate ones of these claims have been so rewritten, they are all now believed to be in condition for allowance.

Claims 36, 49, 62 and 74 were objected to on the basis of perceived informalities. Minor amendments have been made to address the issues discussed in the Office Action. However, the informality mentioned with regard to claim 62 is not present in that claim. That is, the language "main component of the Group III claims" was already present in that claim. Withdrawal of the objections is requested.

Claims 74-85 were rejected under 35 U.S.C. § 112, second paragraph, as indefinite. Claim 74 was amended to clarify that $0.5 \leq y4 \leq 0.85$. It is believed that the rejection under Section 112, second paragraph, has been obviated, and its withdrawal is therefore respectfully requested.

Claim 36 was rejected under 35 U.S.C. § 102(e) as over U.S. Patent Publication No. 2003/0107065 to Taniguchi. Applicants note that the U.S. filing date of Taniguchi is after the date of the Japanese priority application from which this application claims benefit. Applicants file herewith a sworn translation of the Japanese priority document, removing Taniguchi as a prior art reference and obviating this rejection.

Claims 74-82 were rejected under 35 U.S.C. § 102(a) over the admitted prior art (APA). Claims 36-45 were rejected under 35 U.S.C. § 103(a) over the APA in view of Furukawa et al. (U.S. Patent No. 4,951,121, hereinafter Furukawa). Claims 36, 46-48, 49, and 59-61 were rejected under 35 U.S.C. § 103(a) over Teraguchi et al. (U.S. Patent 6,521,998, hereinafter Teraguchi) in view of Nishii et al. (US PgPub 2003/0109088, hereinafter Nishii) and Furukawa. Claims 49-58 were rejected under 35 U.S.C. § 103(a) over the APA in view of Nishii and Furukawa. Claims 62 and 64-70 were rejected under 35 U.S.C. § 103(a) over the APA in view of Kim et al. ("High-temperature structural...", hereinafter Kim). Claims 74 and 83-85 were rejected under 35 U.S.C. § 103(a) as being patentable over Teraguchi in view of the APA.

With regard to the rejection of claim 74 based on the APA, the Examiner construed that claim with the limitation that y_4 equals 1. However, as shown, claim 74 has been amended to specify that $0.5 \leq y_4 \leq 0.85$. In view of this amendment, it is believed clear that the APA does not read on amended claim 74. Withdrawal of the rejection is respectfully requested.

With regard to the rejection of claim 74 based on the combination of Teraguchi in view of the APA, the Examiner also construed that claim with the limitation that y_4 equals 1. However, as discussed above, claim 74 has been amended to specify that $0.5 \leq y_4 \leq 0.85$. In view of the this amendment, it is believed clear that the cited combination of references does not meet the features of amended claim 74. Withdrawal of the rejection is respectfully requested.

With regard to the rejection of independent claim 36 over the APA in view of Furukawa, Applicants comment as follows.

The purpose of Furukawa is to fabricate a GaAs FET with a self-align process. By means of a gate pre-preparing process, Mo is used as a barrier metal for preventing breakage of the schottky contact due to diffusion of the gate metal Au into the GaAs substrate when activation annealing for ion implantation is implemented. On the other hand, the purpose of the invention defined by claim 36 is to improve performance of the completed device, that is, to prevent a lowering of Φ_B , thereby preventing a lowering of the output power due to diffusion of the gate metal Au into the Ni layer by self-heating. These issues, namely the mutual diffusion of Au and Ni (Fig. 4) by self-heating and the lowering of Φ_B (Fig. 2) were discovered first by applicants in experiments. These phenomena are accompanied with the following:

- (a) Self-heating is large due to large current density and high voltage operation; and
- (b) Φ_B depends on a metal contacting the semiconductor.

(Φ_B is determined by work function of the metal.)

These are specific characteristics of GaN FET, as discussed in the specification.

On the other hand, it is well known that in GaAs FETs, there are following characteristics (c) and (d):

- (c) Self-heating is small due to small current density and low voltage operation.
- (d) Φ_B does not depend on a metal contacting the semiconductor.

(Φ_B is determined by a pinning position of the Fermi level.)

Also, the metal diffusion and the lowering of Φ_B due to self-heating have not been reported.

As seen from the foregoing, the power increase engendered by inserting a refractory metal (Mo) layer can be achieved only in the configuration of the present invention, in which a metal having a large work function is used in the first metal layer

that contacts with the GaN semiconductor, and a metal having a low resistivity is used in the third metal layer.

For at least the above reasons, applicants submit that an anticipation rejection over Furukawa, which is based on GaAs FET technologies, cannot be justified.

For at least the reasons set forth above, independent claim 36 is believed clearly patentable over the APA in view of Furukawa.

With regard to the rejection of independent claims 36 and 49 over Teraguchi in view of Nishii and Furukawa, Applicants comment as follows.

As explained in the foregoing paragraphs, the issues of the mutual diffusion of gate metals and the lowering of Φ_B due to self-heating are phenomena specific to GaN FETs and have not been found in GaAs FETs.

The advantage of the power increase engendered by inserting a refractory metal (Mo) layer can be achieved only in the configuration in which a metal having a large work function is used for the first metal layer that contacts with the GaN semiconductor and a low resistivity metal is used for the third metal layer.

For at least this reason, applicants submit that the rejection over Fukuda, which is based on GaAs FET technologies, cannot be justified.

For at least the reasons set forth above, independent claims 36 and 49 are believed clearly patentable over Teraguchi in view of Nishii and Furukawa.

With regard to the rejection of independent claim 62 over the APA in view of Kim's paper, Applicants comment as follows.

Kim's paper is a report on an annealing experiment of a GaN wafer having an Ni/Au electrode, and not on GaN devices. The paper only shows experimental results that an alloy (NiN) was formed on dislocations by diffusion of metal into a GaN

substrate through annealing. A flat surface was maintained on the dislocation free area. There is no description relating to Ni₉/Ni/Au multi structure in Kim's paper.

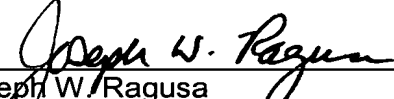
For at least the reasons set forth above, independent claim 62 is believed clearly patentable over the APA in view of Kim's paper.

The other claims in this application are each dependent from one or another of the independent claims discussed above and are therefore believed patentable for the same reasons. Since each dependent claim is also deemed to define an additional aspect of the invention, however, the individual reconsideration of the patentability of each on its own merits is respectfully requested.

In view of the above amendment, applicant believes the pending application is in condition for allowance.

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Respectfully submitted,

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Fig. 1
PRIOR ART

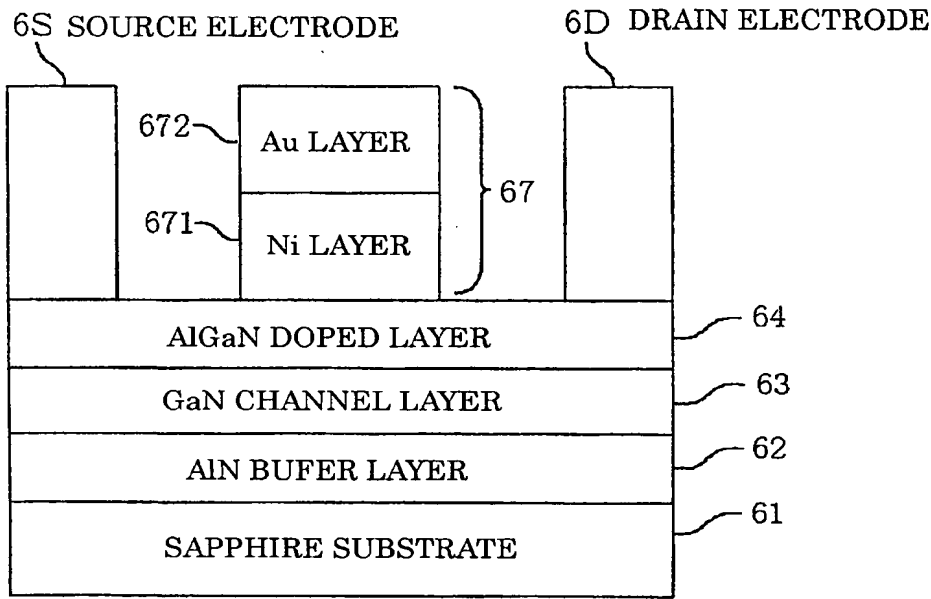


Fig. 2
PRIOR ART

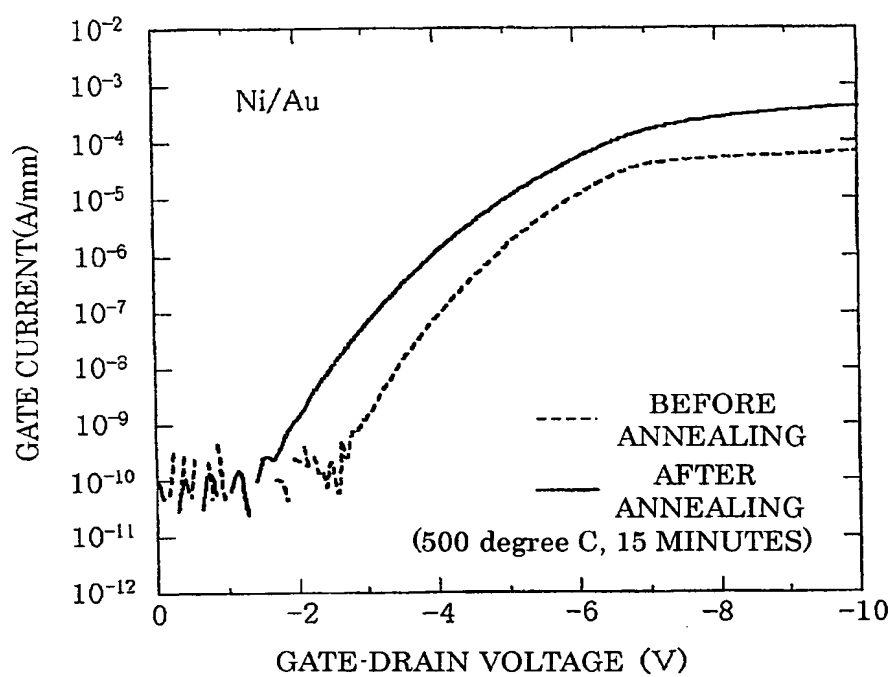


Fig. 3
PRIOR ART

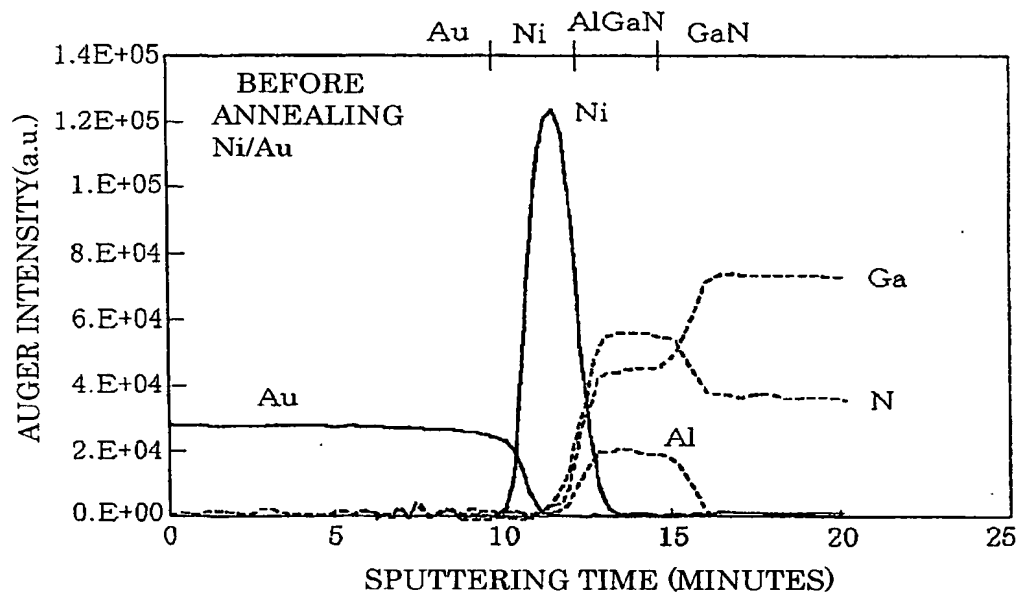


Fig. 4
PRIOR ART

